A Cross-Sectional Survey on Reasons for Initial Placement and Replacement of Single Crowns

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ABSTRACT

This cross-sectional survey investigated the reasons for placement and replacement of single crowns, the type of materials selected for initial placement and evaluated their longevity. Information was collected over 19 months period using a questionnaire focusing on the principal reasons for the placement and replacement of crowns, selected material type and the age of the crowns at the time of replacement. A total of 842 single crowns were evaluated in 476 patients. Of the 842 crowns, 472 (56%) were initial placements and 370 (44%) replacements. The main reason for placement of first single crowns was related to endodontic problems (26.5%). Metal-ceramic was indicated significantly more frequent (88.9%; p<0.01) than other materials for the placement and replacement of single crowns. The median age of the replaced crowns was 6 years.

INTRODUCTION

Providing cost-effective, accessible, satisfactory oral health care to the patients is essential in general dental practice. Placement and replacement of crowns constitute a considerably high percentage of dental services in daily practice.[1] The decision to indicate a crown for a tooth may affect the long-term prognosis of the tooth, the cost of the proposed procedure and the expected lifespan of the restoration. Replacement of restorations affects also approximately 50% of the workload of the dentists,[2] cost of the treatment and well-being of the patient.[3,4] It is therefore critical that dental restorations adequately fulfil their intended purpose and have a positive impact on the integrity of the treated teeth. Due to the hostile oral environment, in some cases dental restorations fail and in the worst-case scenarios, this can lead to further tooth decay and a cycle of re-restoration that is commonly referred as "tooth death spiral".[5] Such restoration cycles are undesirable and costly and even small increases in the lifespan of a restoration can have a significant impact on the continuously increasing expenditures of general dental services.[6] At present, research in this area is very controversial since dental practitioners themselves play a significant role in the failure of restorations and rising costs of dental therapies.

According to a national survey where ten-year clinical condition of adults in the United Kingdom (UK) was assessed,[7] the results indicated that over one-third (34%) of the patients received at least one crown, 20% had more than one crown and 5% had at least six crowns. In another survey, assessing the trends relating to the placement of crowns in UK between 1948 and 1988, steady increase in the number of patients were noted who had received dental crowns and that patients aged between 31 and 40 had received the

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highest number of crowns.[8] In 1997/98, 1.331.143 crowns were made in adults within general dental services in England and Wales, and in 2004/2005 this figure increased to 1.131.590.[9]

In Turkey, direct restorations represent the largest number of restorations but like many other countries worldwide, the indication of crowns is also increasing. According to figures released by the Turkish Ministry of Health in 2009, a total of 2.492.383 crowns were performed within Public Dental Services, with an increase to 3.043.235 in 2010 and to 5.390.146 in 2012.[10] In light of the increasing indication of crowns as dental restorations, it is critical to collect information on their survival over the years in order to ensure that dental services with crowns remain cost-effective and efficient.

A number of surveys have investigated the reasons for placement and replacement of direct (amalgam, composite) restorations, providing extended knowledge regarding reasons for restorative therapies and restorative material selection at dental schools, public dental hospitals and private practices.[1,2,9,11-13] Accordingly, the main reasons for complications or failures remain to be seconder caries, bulk fracture, poor anatomic form, etc. However, scarce information is available regarding reasons for placement and replacement of crowns being only limited to European countries.[1,2,9,11,13,14]

The objectives of this cross-sectional survey therefore were to assess the reasons for placement and replacement of single crowns and collect information on the type of initially placed and replaced crowns in Turkey. The null hypothesis hypotheses tested were that a) the reasons for placement and replacement of crowns and b) selected material type would not show significant difference.

MATERIALS AND METHOD

STUDY DESIGN AND DATA COLLECTION

The methods employed in this study were based on a previous prospective survey conducted to collect information on the principal reasons for the placement and replacement of crowns.[1] This cross-sectional study was carried out using a questionnaire. Two investigators (R.Ü., Z.Ü) collected data from patients attended Kirikkale University, Faculty of Dentistry (KUFD), Department of Prosthodontics between July 2010 and April 2012. Prior to the study, the two investigators were calibrated for their assessment on a subset of 20 cases. Kappa test was performed in order to evaluate the agreement between the investigators, resulting in Kappa index of 0.85.

INCLUSION AND EXCLUSION CRITERIA

The inclusion criteria involved patients: a) who needed single crowns and/or had single crowns to be replaced, b) 18 years of age or older, c) willing and able to give written informed consent, d) having natural teeth as opposing dentition, e) having good oral hygiene or those completed initial periodontal treatment including supragingival scaling and received oral hygiene instructions. Patients a) who refused or was not able to give informed consent, b) who were pregnant patients, c) aged less than 18 years old and d) who had poor oral hygiene, were excluded from the study.

QUESTIONNAIRE ADMINISTRATION

The questionnaire used in the present study consisted of two parts. In the first part, information was elicited in regard to the age and gender of the patients. In the second part, data were collected related to the tooth restored, type of crown material used in the placement and the replacement of crowns (i.e. metal-ceramic, gold, zirconia or other all-ceramic materials). For new crowns, the reason for placement was recorded (i.e. restoration failure, tooth fracture, aesthetics, wear, endodontic reasons, occlusion related problems, primary caries and other reasons) *(Table 1)*. For replaced crowns, the previous restorative material and the primary reason for replacement (i.e. secondary caries, unacceptable marginal adaptation, debonded crown, crown fracture, tooth fracture, aesthetics, wear, endodontic reasons, change of material, occlusion related problems and other reasons) were recorded *(Table 2)*. Data regarding gingival and periodontal (i.e. plaque index, gingival index) conditions were not recorded.

Table 1. Reasons for placement of crowns and their corresponding descriptions.

Reasons	Description
Failed restorations	Includes all reasons for the failure of crowns such as secondary (recurrent) caries, fractures (bulk and marginal) requiring placement of the crown
Tooth fracture	All forms of tooth fracture, including those that extend into the crown and fracture due to trauma
Aesthetics	Crowns placed to improve aesthetics for any reason (i.e. tetracycline discoloured teeth)
Wear	Wear of tooth tissues by attrition, abrasion and erosion
Endodontic reasons	Endodontic reasons for crown provision including the need for post and cores to obtain adequate retention of the crown
Occlusion problems	Occlusal reasons for crown placement
Primary caries	Approximal primary caries not related to an existing crown
Other	Any other reasons for placement of a crown

Table 2. Reasons for replacement of crowns and their corresponding descriptions.

Reasons	Description
Secondary/ recurrent caries	Caries detected at the margins of an existing crown
Unacceptable marginal adaptation	Crowns with degraded or poor margins without secondary caries
Debonded crown	Cementation failure leading to the need for crown replacement
Crown fracture	Fracture of any part of the crown that is the reason for replacement
Tooth fracture	Any form of tooth fracture that does not involve the crown but is the reason for crown replacement
Aesthetics	Aesthetic reason for the crown to be replaced (i.e. gingival recession exposing the crown margin)
Wear	Wear by attrition, abrasion or erosion that results in the need for crown replacement
Endodontic reasons	Endodontic reasons that lead to the need for crown replacement
Change of material	Change in the material considered as failure of the crown
Occlusion problems	Reasons related to occlusion for crown replacement
Other	Any other reasons for the replacement of a crown

STATISTICAL ANALYSIS

The data were collected using an alpha-numerical coding system and recorded following numerical transformation into a Statistical Package for the Social Sciences (version 20.0, SPSS Inc, Chicago, IL, USA). Data were analyzed using chi-squared test. P values less than 0.05 was considered to be statistically significant.

RESULTS

GENERAL DATA

A total of 476 patients with a mean age of 35 years old (min: 17, max: 83 years old) from Middle-Anatolian region, having 842 single crowns were involved in the study. Of the 842 crowns, 472 (56%) were initial placements and 370 (44%) replacements. The distribution of the crowns between males (53.4%) and females (46.6%) were not significant (p>0.05).

REASONS FOR PLACEMENT/REPLACEMENT OF CROWNS

The main reason for the first restoration and single crowns was related to endodontic problems (26.5%), followed by aesthetics (21.2%), primary caries (17.7%) and failed restorations (10.6%) *(Table 3)*. On the other hand, the most common reason for the replacement of crowns was endodontic problems (26.5%) followed by unacceptable margin adaptation (17.8%). As such, the need to replace crowns as a result of the endodontic reasons was deemed to be significantly higher than those of other reasons (p=0.003). The median age of the replaced crowns was 6 years. The majority of the replaced crowns were in the age groups between 30 and 49 years old *(Table 4)*.

DISTRIBUTION OF TEETH RESTORED WITH CROWNS

The number of crowns in the maxilla (n=438, 52%) was slightly higher than in the mandible (n=404, 48%). Overall, 25.6% of the crowns were on molars in the mandible followed by maxillary molars (22.5%) and premolars (16.5%) *(Table 5)*. The least incidence of crowns was in canines in both the mandible and maxilla (3.4% each).

The incidence of crown replacement was more common in maxillary molars (27%) followed by mandibular molars (25.4%), maxillary premolars (14.6%), mandibular premolars (13%), maxillary incisors (8.1%), mandibular incisors, canines and maxillary canines, respectively.

CROWN MATERIAL

Metal-ceramic was indicated significantly more frequent than other materials for the placement (78.3%; p=0.001) and replacement of single crowns (88.9%; p<0.01) *(Table 6)*. Zirconia was the second most preferred material (18.2%) after metal-ceramics. None of the patients requested gold crowns and only 1.6% requested all-ceramic crowns for their first crowns.

Of the 214 replaced metal-ceramic crowns, 188 of them were replaced with the same material while only 26 of them were replaced with zirconia *(Table 7)*. In case of failed zirconia crowns, replacement was performed exclusively with the same material. The failure reasons for zirconia crowns were endodontic reasons (n=5) and fractures (n=3).

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Table 3. Incidence of reasons for placement and replacement of crowns.

Reasons for placement	N=472 (%)	Reasons for replacement	N=370 (%)
Failed restorations	50 (10.6)	Secondary caries	26 (7)
Tooth fracture	24 (5.1)	Unacceptable margin adaptation	66 (17.8)
Wear	40 (8.5)	Lost crown	8 (2.2)
Endodontic reasons	125 (26.5)	Crown fracture	14 (3.8)
Occlusion problems	16 (3.4)	Tooth fracture	24 (6.5)
Primary caries	84 (17.7)	Aesthetics	60 (16.3)
Aesthetics	100 (21.2)	Wear	12 (3.2)
Other	33 (7)	Endodontic reasons	98 (26.5)
		Change of material	43 (11.6)
		Occlusion problems	6 (1.6)
		Other	13 (3.5)

Table 4. Distribution of number of placement and replacement of crowns based on for patient age groups.

Age group	Placement (n)	Replacement (n)
18-29	30	11
30-39	173	127
40-49	140	156
50-59	76	48
60≥	53	28
Total	472	370

Table 5. Incidence (N; %) of placement and replacement of crowns according location and tooth type.

Location/ Teeth	Placement (N; %)	Replacement (N; %)
Maxilla		
Incisors	42 (8.9)	30 (8.1)
Canines	16 (3.4)	12 (3.2)
Premolars	78 (16.5)	54 (14.6)
Molars	106 (22.5)	100 (27)
Subtotal	242 (51.3)	196 (52.9)
Mandible		
Incisors	33 (7)	18 (4.9)
Canines	16 (3.4)	14 (3.8)
Premolars	60 (12.7)	48 (13)
Molars	121 (25.6)	94 (25.4)
Subtotal	230 (48.7)	174 (47.1)
Total	472 (100)	370 (100)

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Table 6. Distribution of materials (N; %) used for placement and replacement of crowns.

Crown Material	Placement (N; %)	Replacement (N; %)	Total (N; %)
Metal-ceramic	370 (78.3)	214 (57.8)	584 (69.3)
Gold	0	20 (5.4)	20 (2.4)
Metal-acrylic	9 (1.9)	122 (33)	131 (15.5)
Veneered zirconia	86 (18.2)	8 (2.2)	94 (11.2)
Other all-ceramics	7 (1.6)	6 (1.6)	13 (1.6)
Total	472 (100)	370 (100)	842 (100)

Table 7. Distribution of materials used for failed crowns and the selected material type for replacement.

Materials of failed crowns	New materials used for replacement		
	Metal-ceramic	Zirconia	Others
Metal-ceramic	188	26	0
Zirconia	0	14	0
Others	138	4	0

DISCUSSION

Gaining insights into the reasons for placement and replacement of restorations and the selected materials help understand failure reasons and estimate longevity of the restorations in contemporary clinical practice. Based on the results of this study, endodontic reasons were significantly higher than those of other reasons and metal-ceramic was significantly more frequently indicated as a crown material than those of other materials. Thus, both null hypotheses were rejected.

Metal-ceramic crowns have the longest track in prosthetic dentistry being available since more than 40 years.[15] They have favourable mechanical properties with high fracture resistance but concerns exist regarding their optical properties.[15] On the contrary, all-ceramic crowns are aesthetically more pleasing but less resistant to chipping and fractures compared to their metal-ceramic counterparts.[15] Major advances have been made in all-ceramic technologies during the last two decades. However, it is still not evident whether or not the improvements have increased their longevity to the level of metal-ceramics. In order to make evidence-based decisions regarding the reimbursement of dental crowns, policy makers require information on the long-term benefits and costs associated with different crown materials.

In a previous survey on 688 metal-ceramic single crowns placed in a specialist practice indicated corono-radicular and root fractures as major (56%) causes of the retreatments.[16] In another study, main retreatment reason were tooth and crown fractures.[1] While Walton *et al.*[17] attributed this reason to secondary caries, others endorsed it to poor aesthetics.[18,19] The most common reason for crown replacement in the present study was endodontic reasons (26.5%). This figure is considerably higher than previous reports. Burke and Lucarotti reviewed 10.4[26] crowned teeth with re-interventions and reported that 36% of them were due to debonding and only 12% as a result of endodontic treatment.[2] In another study in UK, 802 crowns were assessed radiographically and of the 458 teeth that were vital during preparation session, 87 (19%) of them presented radiographic signs of periradicular disease when examined at different time points.[20] Similarly, the results of a literature review of the past 50 years on 823 crowns, only 27 (3%) of them required endodontic treatment.[21] Likewise, assessment of 403 crowns in 130 patients signified 5.7% need for endodontic treatment up to 6 years after crown placement.[22] In a more recent practice-based study, endodontic retreatment need after crown placement was found less than 4%[23] again being less than the incidence (26.5%) observed in the present study.

Caries has been the most commonly reported reason for failure of fixed prostheses yielding to retention loss of crowns.[24-26] However, controversial results are present in this regard. While Behr *et al.* reported less incidence of recurrent caries (1.3%) or loss of retention (3.8%) as failure reasons in 997 metal-ceramic single crowns,[27] in another study, these figures were 2% for each parameter, respectively.[21] In this study, secondary caries was accounted to 7% as a reason for replacement of crowns. Much attention was given for establishing resistance form in the underlying preparations through resistance grooves.[28] This could be the reason for limited number of debonding cases (2.2%).

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The percentage (3.8%) of crowns that required replacement as a result of crown fracture in the current study was lower than previous studies where the fracture incidence of 12[23] and 27% was reported.[1] On the other hand, all-ceramic crowns demonstrated overall fracture rate of 4.4% over five years, irrespective of the materials used.[29]

Poor aesthetics was another important cause for replacement in this study, accounting for 16% of crown replacements. This finding was considerably lower compared to the data reported collected at a dental school in Nigeria.[19]

Overall, in this study maxillary and mandibular teeth received similar percentage of initial crowns. Controversial reports are present in this regard where more crowns were reported to be placed on the maxilla than in the mandible with maxillary incisors being the most frequently crowned teeth.[1,2,16,30] The distribution of crowned teeth within the arches and the predominance of posterior placements reflect that aesthetics was not the major reason for crown replacement.

In the present study, metal-ceramics were the most common (78.3%) type of crowns provided to the patients for both initial and replaced crowns. During the last decade, worldwide, demands for aesthetically pleasing restorations has increased dramatically. This trend has led to the development of all-ceramic systems. In Turkey, general health insurance system compensates for the majority of dental treatments performed at the state hospitals and teaching institutions, except for crowns for which patients are only required to pay the technician fee. However, the cost of dental laboratory fees greatly varies for zirconia and metal-ceramics where the latter is often significantly cheaper than those of all-ceramic options. As for the first crown placement, the high number of metal-ceramic crown indication could be attributed to its low cost with acceptable aesthetic results and mechanical strength.

In the current study, the median age of the crowns replaced was 6 years. This study provides information on failure types but cannot be compared with longitudinal studies since the data were not collected based on the age of the crowns that were still in service. Similar median survival of meta-ceramic crowns with 5.6,[19] 6.1[31] years but also longer (8.3,[17] 10[1] and 13[32] years) survival periods have been reported. Disagreement in the clinical life expectancy of crowns could be attributed to a number of factors including variations in oral hygiene of the patients, technical differences in the quality and fabrication of crown materials used in different countries, the number of teeth involved in the studies and the differences in methodology of studies (longitudinal, practice-based or retrospective).

Due to the lack of previous data regarding the type of luting cements, it was not possible to evaluate the effect of cement type on failure modes of replaced crowns. The influence of patient age for being a reason for placement and replacement of direct (amalgam, composite) restorations has been previously shown.[33-36] The present study was unable to explore the relation between the age of the patients but replacements were mainly in the age group above 30 years of old.

Knowledge on the clinical complications in fixed prosthodontics could encourage clinicians to complete a thorough diagnosis, make the most appropriate treatment plan, communicate realistic expectations with their patients regarding to longevity and plan appropriate time intervals at which post-treatment care should be provided. Although a significant amount of studies are available on clinical complications, studies have yet to provide a comprehensive comparison of complications associated with the most commonly applied restorations and/or prostheses.[21] Therefore, the sample in this study could be considered as a contribution to the collection of data regarding at least the failure types that yielded to replacement of single crowns.

CONCLUSIONS

The results of this cross-sectional survey indicated that the incidence of single crown indication was more common in mandibular molars and the main reason for placement and replacement being endodontic complications. The most commonly used crown material was metal-ceramic with a median survival time of 6 years.

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